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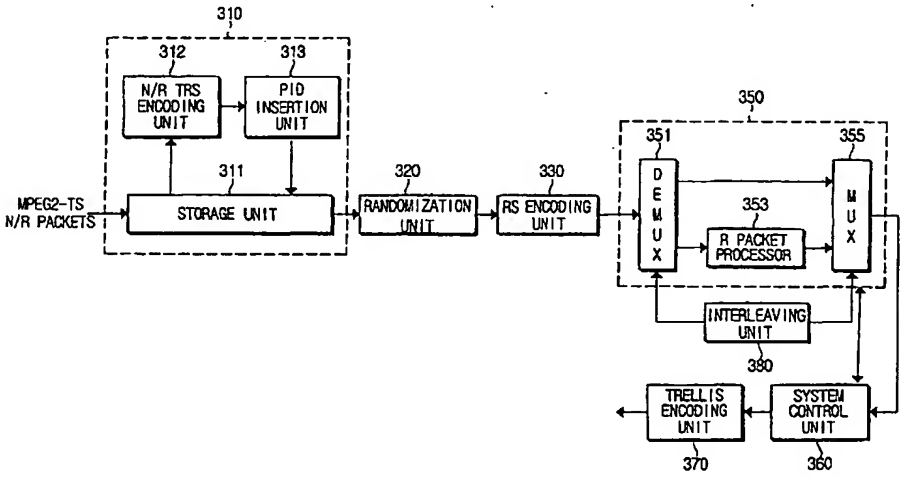
(54) Title: ROBUST ERROR CORRECTION ENCODING/DECODING APPARATUS AND METHOD FOR DIGITAL DUAL-STREAM BROADCAST RECEPTION/TRANSMISSION SYSTEMS



(57) Abstract: An error correction encoding/decoding apparatus and method a for digital dual-stream broadcast transmission/reception systems. An error correction encoding apparatus comprises a TRS encoding part for applying the transversal encoding to normal data packets and robust data packets and appending parity packets, a randomization unit for randomizing the data packets and the parity packets according to a predetermined pattern, an RS encoding unit for appending parities to the randomized data packets and parity packets, a packet format unit for splitting the data packets and the parity packets into normal data and robust data and processing the data, and a system control unit for controlling the packet format unit. Accordingly, a robust error correction encoding apparatus can be provided for digital dual-stream broadcast transmission systems to which the Transversal Reed-Solomon(TRS) encoding is applied.

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Description

ROBUST ERROR CORRECTION ENCODING/DECODING APPARATUS AND METHOD FOR DIGITAL DUAL-STREAM BROADCAST RECEPTION/TRANSMISSION SYSTEMS

Technical Field

[1] The present invention relates to an error correction encoding/decoding apparatus for American ATSC digital terrestrial broadcast reception/transmission systems, and more particularly to a robust error correction encoding/decoding apparatus and method for digital dual-stream broadcast reception/transmission systems which split data into normal and robust data for processing, receiving, and transmitting the data.

Background Art

[2] FIG. 1 and FIG. 2 are block diagrams for schematically showing an American ATSC standard reception/transmission system disclosed in Republic of Korea Patent Application No 2003-0067522 filed by the Applicant.

[3] In a transmission system as shown in FIG. 1, the Transversal Reed Solomon(TRS) encoding unit 12 produces parity packets in columns with respect to MPEG2-TS packets stored in the storage unit 11, and the header insertion unit 13 inserts parity packet headers(PIDs) for compatibility with existing reception systems. Next, the data packets and parity packets are randomized in a certain pattern by the randomization unit 14, and the RS encoding unit 15 generates and adds 20-byte parities to the data packets and parity packets.

[4] On the other hand, FIG. 2 is a block diagram for schematically showing a reception system corresponding to the reception/transmission system shown in FIG. 1. The RS decoding unit 21 corrects errors of data packets and parity packets in row direction by using 20-byte parities added to individual packets.

[5] The randomization unit 22 de-randomizes the data packets and parity packets error-corrected in the row direction by the RS decoding unit 21, and stores the de-randomized data packets and parity packets in the storage unit 23. The TRS decoding unit 24 corrects data packet errors in the column direction by use of the de-randomized parity packets, and updates the stored data.

[6] Next, the randomization unit 22 randomizes the de-randomized data packets and parity packets, and the RS decoding unit 21 corrects errors in the row direction in the

row direction by using the parity packets once more, and the de-randomization unit 25 de-randomizes the packets.

Disclosure of Invention

Technical Problem

[7] However, As above, the Republic of Korea Patent Application No. 2003-0067522 filed by the Applicant discloses only the concept of applying the TRS encoding and decoding to the digital dual-stream broadcast receptions and transmissions in which data split into the normal and robust data is sent together, but does not disclose concrete embodiments.

Technical Solution

[8] The present invention has been developed in order to solve the above drawbacks and other problems associated with the conventional arrangement. An aspect of the present invention is to provide an error correction encoding/decoding apparatus and method for digital dual-stream broadcast reception/transmission systems in which the transversal reed Solomon encoding/decoding method is applied.

[9] The foregoing and other objects and advantages are substantially realized by providing an error correction encoding apparatus for digital dual-stream broadcast transmission systems, according to the first embodiment of the present invention, comprising a Transversal Reed-Solomon(TRS) encoding part for applying the transversal encoding to normal data packets and robust data packets and appending parity packets; a randomization unit for randomizing the data packets and the parity packets according to a predetermined pattern; an RS encoding unit for encoding the randomized data packets and parity packets and appending parities of predetermined bytes; a packet format unit for splitting the data packets and the parity packets into normal data and robust data and processing the data according to respective data formats; and a system control unit for controlling the packet format unit to split into the normal data and the robust data and process the data packets and the parity packets.

[10] The foregoing and other objects and advantages are substantially realized by providing an error correction encoding apparatus for digital dual-stream broadcast transmission systems, according to the second embodiment of the present invention, comprising a randomization unit for randomizing normal data packets and robust data packets according to a predetermined pattern; a TRS encoding part for applying the transversal encoding to the randomized normal data packets and robust data packets and appending parity packets; an RS encoding unit for appending parities of pre-determined bytes to the data packets and the parity packets; a packet format unit for

splitting the data packets and the parity packets into normal data and robust data and processing the data according to respective data formats; and a system control unit for controlling the packet format unit to split into the normal data and the robust data and process the data packets and the parity packets. The randomization unit randomizes the parity packets in accordance with a predetermined pattern.

[11] The foregoing and other objects and advantages are substantially realized by providing an error correction encoding apparatus for digital dual-stream broadcast transmission systems, according to the third embodiment of the present invention, comprising a randomization unit for randomizing normal data packets and robust data packets according to a predetermined pattern; an RS encoding unit for appending parities of predetermined bytes to the data packets; a TRS encoding part for applying the transversal encoding to the data packets and appending parity packets; and a packet format unit for splitting the data packets and the parity packets into normal data and robust data and processing the data according to respective data formats, wherein the randomization unit randomizes the parity packets according to the predetermined pattern and the RS encoding unit appends the parity of predetermined bytes to the randomized parity packets.

[12] The foregoing and other objects and advantages are substantially realized by providing an error correction decoding apparatus for digital dual-stream broadcast reception systems, according to the fourth embodiment of the present invention, comprising a packet re-format unit for splitting input data packets and parity packets into normal data and robust data and processing data according to respective data formats; an RS decoding unit for correcting errors of the packets by use of parities of predetermined bytes included in the packets; a de-randomization/randomization unit for de-randomizing the packets corresponding to error correction encoding; and a TRS decoding part for correcting errors of the packets by use of the parity packets, wherein the de-randomization/randomization unit randomizes the packets error-corrected in the TRS decoding part.

Advantageous Effects

[13] As aforementioned, the present invention can provide error correction encoding/ decoding apparatus and method for digital dual-stream broadcast transmission/ reception systems to which the TRS encoding and decoding are applied.

[14] The digital dual-stream broadcast transmission/reception system according to the present invention can obtain an SNR gain with respect to normal data and robust data by applying the TRS encoding, and improve the performance of an equalizer together

with the SNR gain by carrying out the robust data process with respect to parity packets of normal data.

[15] The foregoing embodiments and advantages are merely exemplary and are not to be construed as limiting the present invention. The present teaching can be readily applied to other types of apparatuses. Also, the description of the embodiments of the present invention is intended to be illustrative, and not to limit the scope of the claims, and many alternatives, modifications, and variations will be apparent to those skilled in the art.

Description of Drawings

[16] The above aspects and features of the present invention will be more apparent by describing certain embodiments of the present invention with reference to the accompanying drawings, in which:

[17] FIG. 1 and FIG. 2 are block diagrams for schematically showing an error correction encoding/decoding apparatus disclosed in Republic Of Korea Patent Application No. 2003-0067522 filed by the Applicant;

[18] FIG. 3 is a block diagram for schematically showing an error correction encoding apparatus for digital dual-stream broadcast transmission systems according to the first embodiment of the present invention;

[19] FIG. 4 through FIG. 6 are views for showing structures of dual-stream transmission data frames;

[20] FIG. 7 is a flow chart for showing an error correction encoding process for the error correction encoding apparatus of FIG. 3;

[21] FIG. 8 is a block diagram for schematically showing an error correction encoding apparatus for digital dual-stream broadcast transmission systems according to the second embodiment of the present invention;

[22] FIG. 9 is a flow chart for showing an error correction encoding process for the error correction encoding apparatus of FIG. 6;

[23] FIG. 10 is a block diagram for schematically showing an error correction encoding apparatus for digital dual-stream broadcast transmission systems according to the third embodiment of the present invention;

[24] FIG. 11 is a flow chart for showing an error correction encoding process for the error correction encoding apparatus of FIG. 8;

[25] FIG. 12 is a block diagram for illustrating another TRS encoding unit for the error correction encoding apparatus according to an embodiment of the present invention;

[26] FIG. 13 is a block diagram for schematically showing an error correction decoding

apparatus for digital dual-stream broadcast reception systems according to an embodiment of the present invention;

[27] FIG. 14 is a view for illustrating a TRS decoding unit of the error correction decoding apparatus according to an embodiment of the present invention;

[28] FIG. 15 is a flow chart for showing an error correction decoding process for the error correction encoding apparatus according to the first embodiment of the present invention; and

[29] FIG. 16 is a flow chart for showing an error correction decoding process for the error correction encoding apparatuses according to the second and third embodiments of the present invention.

Best Mode

[30] Hereinafter, the present invention will be described in detail with reference to the accompanying drawings.

[31] FIG. 3 is a block diagram for schematically showing an error correction encoding apparatus for digital dual-stream broadcast transmission systems according to the first embodiment of the present invention. The error correction encoding apparatus as shown in FIG. 3 has a TRS encoding part 310, a randomization unit 320, a Reed Solomon (RS) encoding unit 330, a packet format part 350, an interleaving unit 360, a Trellis encoding unit 370, and a system control unit 380.

[32] The TRS encoding part 310 has a storage unit 311, an N/R TRS encoding unit 312, and a PID insertion unit 313, applies the transversal encoding to normal data packets and robust data packets to generate parity packets, and inserts packet headers (PIDs) in the generated parity packets.

[33] FIGS. 4 to 6 are views for showing structures of dual-stream transmission data frames according to the present invention. In FIGS. 4 to 6, the dual-stream transmission data frames are structured with normal data and robust data.

[34] The TRS encoding part 310 applies the transversal encoding to data packets to append parity packets, and the parity packets are preferably appended in two methods as follows.

[35] First, as shown in FIG. 4 and FIG. 5, there is a method appending (M1-K1) normal parity packets and (M2-K2) robust parity packets corresponding to K1 normal data packets and k2 robust data packets, respectively, and, second, as shown in FIG. 6, there is a method appending (M-(K1+K2)) parity packets to the entire packets of K1 normal data packets and K2 robust data packets.

[36] The randomization unit 320 randomizes the data packets and parity packets in a

predetermined pattern. The RS encoding unit 330 appends a parity of bytes to each of the randomized packets.

[37] The packet format part 350 has a demultiplexer 351, an R packet processor 353, and a multiplexer 355, and splits input packets into the normal data and the robust data and processes the data corresponding to the packet formats under the controls of the system control unit 380.

[38] The demultiplexer 351 splits input packets into the normal data and the robust data as shown in FIGS. 4 through 6, for example, according to the controls of the system control unit 380. As shown in FIG. 4, the demultiplexer 351 splits normal data packets and normal parity packets into the normal data, and robust parity packets and robust parity packets into the robust data, or, as shown in FIG. 5, splits the normal data packets into the normal data, and splits normal parity packets, robust data packets, and robust parity packets into the robust data.

[39] Further, as shown in FIG. 6, the demultiplexer 351 splits the normal data packets into the normal data, and the robust data packets and parity packets into the robust data.

[40] The packets split into the normal data by the demultiplexer 351 are processed as the normal data and outputted to the multiplexer 355, and the packets split into the robust data is processed to the robust data in certain ratios, for example, ½, and ¼, by the R packet processor 353, and outputted to the multiplexer 355.

[41] The interleaving unit 360 interleaves and re-arranges the processed data packets in bytes according to packet formats. The Trellis encoding unit 370 applies the Trellis encoding to the interleaved data for re-arrangement into bits.

[42] FIG. 7 is a flow chart for showing an error correction encoding process for the error correction encoding apparatus according to the first embodiment of FIG. 3. Hereinafter, description will be made in detail on the error correction encoding process according to the first embodiment of the present invention, with reference to FIGS. 4 through FIG. 6.

[43] In an MPEG transmission system (not shown), normal data packets (a) and robust data packets (b) are stored in the storage unit 311 (S111).

[44] The N/R TRS encoding unit 312 applies the transversal encoding to the normal data packets (a) and the robust data packets (b) to generate parity packets (S113). As shown in FIG. 4 and FIG. 6, normal parity packets (c) are generated with respect to the normal data packets (a), and robust parity packets (d) are generated with respect to the robust data packets (b). Further, as shown in FIG. 4C, the N/R TRS encoding unit 312

generates parity packets (D) with respect to the entire packets of the normal data packets (a) and robust data packets (b).

[45] The PID insertion unit 313 inserts packet headers (PIDs) into parity packets (S115). As shown in FIG. 4 and FIG. 5, the headers (PIDs) (e) are inserted into the normal parity packets (b), and the headers (PID) (f) are inserted into the robust parity packets (b). Further, as shown in FIG. 4C, the headers (PIDs) (F) are inserted into the parity packets (D) generated for the entire packets of the normal data packets (a) and robust data packets (b).

[46] As above, parity packets are generated for the normal data packets or the robust data packets, or for the entire packets, and headers (PIDs) are inserted into the generated parity packets, and then the parity packets are stored in the storage unit 311 (S117).

[47] The randomization unit 320 randomizes the data packets and parity packets stored in the storage unit 311 in a predetermined pattern (S119).

[48] The RS encoding unit 350 appends a parity of predetermined bytes to the randomized packets (S121). As shown in FIG. 4 through FIG. 6, parities of 20 bytes are appended.

[49] The packet format part 350 splits input packets into the normal data and the robust data according to the controls of the system control unit 580, and processes the data according to the respective data formats (S123).

[50] The interleaving unit 360 interleaves the data packets processed according to the respective data formats (S125), and the Trellis encoding unit 427 applies the Trellis encoding to the interleaved packets for re-arrangement in bit (S127).

Mode for Invention

[51] FIG. 8 is a block diagram for schematically showing an error correction encoding apparatus for the digital dual-stream broadcast transmission systems according to the second embodiment of the present invention. As shown in FIG. 8, the error correction encoding apparatus has a randomization unit 410, a TRS encoding part 420, an RS encoding unit 430, a packet format part 450, an interleaving unit 460, a Trellis encoding unit 470, and a system control unit 480.

[52] The randomization unit 410 randomizes in a predetermined pattern the normal and robust data packets inputted from an MPEG transmission system (not shown), and parity packets fed back from the TRS encoding unit 420 as well.

[53] The TRS encoding unit 420 has a storage unit 421, an N/R TRS encoding unit 422, and a PID insertion unit 423, applies the transversal encoding to the randomized

normal data packets and robust data packets to generate parity packets, and inserts headers (PIDs) into the generated parity packets.

[54] The RS encoding unit 430 appends parities of predetermined bytes to the randomized data and parity packets.

[55] The packet format part 450 has a demultiplexer 451, an R packet processor 453, and a multiplexer 455, splits individual packets inputted according to the controls of the system control unit 480 into the normal data and the robust data, and process the split data according to respective data formats. In here, the packets can be diversely split into the normal and robust data as described in the first embodiment with reference to FIG. 4 through FIG. 6.

[56] The interleaving unit 460 interleaves the packets processed according to data formats for re-arrangement in byte. The Trellis encoding unit 470 applies the Trellis encoding to the interleaved data for re-arrangement in bit.

[57] FIG. 9 is a flow chart for showing an error correction encoding process for the error correction encoding apparatus of FIG. 8 according to the second embodiment of the present invention. Hereinafter, description will be made in detail on the error correction encoding process according to the second embodiment with reference to FIG. 4 through FIG. 6.

[58] The normal data packets (a) and the robust data packets (b) are inputted from the MPEG transmission system (not shown), and the randomization unit 410 randomizes the normal data packets (a) and the robust data packets (b) according to a pre-determined pattern (S211).

[59] The randomized normal data packets (a) and robust data packets (b) are stored in the storage unit 421 (S213).

[60] The N/R TRS encoding unit 422 applies the transversal encoding to the randomized normal data packets (a) and robust data packets (b) to generate parity packets (S215). As shown in FIG. 4 and FIG. 5, the N/R TRS encoding unit 422 generates the normal parity packets (c) with respect to the normal data packets (a), and generates the robust parity packets (d) with respect to the robust data packet (b). Further, as shown in FIG. 6, the N/R TRS encoding unit 422 generates parity packets (D) with respect to the normal data packets (a), robust data packets (b), and the entire packets.

[61] The PID insertion unit 423 inserts headers (PIDs) into parity packets (S217). As shown in FIG. 4, the PID insertion unit 423 inserts the headers (PIDs) (e) into the normal parity packets (b), and the headers (PIDs) (f) into the robust parity packets (b).

Further, as shown in FIG. 6, the PID insertion unit 423 inserts the headers (PIDs) (F) into the parity packets (D) generated for the normal data packets (a), the robust data packets (b), and the entire packets.

[62] As above, the parity packets into which the headers (PIDs) are inserted are fed back to the randomization unit 410, randomized according to a predetermined pattern, and stored in the storage unit 421 (S219).

[63] The RS encoding unit 430 appends parities of predetermined bytes to data packets and parity packets that are stored in the storage unit 421 (S221). As shown in FIG. 4 through FIG. 6, the RS encoding unit 430 appends parities of 20 bytes to the packets.

[64] The packet format part 450 splits input packets into the normal data and the robust data according to the controls of the system control unit 480, and processes data according to respective packet formats (S223).

[65] The interleaving unit 460 interleaves the packets processed according to the data formats for re-arrangement in byte (S225), and the Trellis encoding unit 470 applies the Trellis encoding to the interleaved data for re-arrangement in bit (S227).

[66] FIG. 10 is a block diagram for schematically showing an error correction encoding apparatus for digital dual-stream broadcast transmission systems according to the third embodiment of the present invention. As shown in FIG. 10, the error correction encoding apparatus has a randomization unit 510, an RS encoding unit 520, a TRS encoding part 530, a packet format part 550, an interleaving unit 560, a Trellis encoding unit 570, and a system control unit 580.

[67] The randomization unit 510 randomizes according to predetermined patterns the normal data packets and the robust data packets that are outputted from the MPEG transmission system (not shown), and also randomizes the parity packets fed back from the TRS encoding part 530.

[68] The RS encoding unit 520 appends parities of predetermined bytes to the randomized normal data packets and robust data packets, and also appends parities of predetermined bytes to the randomized parity packets fed back from the TRS encoding part 530.

[69] The TRS encoding part 530 has a storage unit 531, an N/R TRS encoding unit 532, and a PID insertion unit 533, applies the transversal encoding to the parity-appended normal data packets and robust data packets to generate parity packets, and inserts headers (PIDs) into the generated parity packets.

[70] In here, the process for generating the parity packets can generate parity packets for data packets to which parities are appended, and also generate parity packets for

data packets except for parities. In case of the data packets to which parities are appended, packets go through a re-arrangement process before headers are inserted into the parity packets. That is, if the parity packets are generated with respect to the data packets including the parities, the parity packets have a size of 207 bytes. Thus, in consideration of 20-byte parities being appended by the RS encoding unit 520, the parity packets are re-arranged to the size of 187 bytes.

[71] The packet format part 550 has a demultiplexer 551, an R packet processor 553, and a multiplexer 555, splits input packets into the normal data and the robust data according to the controls of the system control unit 580, and processes the data according to respective data formats. In here, the packets can be diversely split into the normal and robust data as described in the first embodiment with reference to FIG. 4 through FIG. 6.

[72] The interleaving unit 560 interleaves the packets processed according to the packet formats for re-arrangement in byte. The Trellis encoding unit 570 applies the Trellis encoding to the interleaved data for re-arrangement in bit.

[73] FIG. 11 is a flow chart for showing an error correction encoding process for the error correction encoding apparatus of FIG. 10 according to the third embodiment of the present invention. Hereinafter, description will be made in detail on the error correction encoding process according to the third embodiment of the present invention with reference to FIG. 4 through FIG. 6.

[74] The normal data packets (a) and the robust data packets (b) are inputted from an MPEG transmission system (not shown), and the randomization unit 510 randomizes the normal data packets (a) and the robust data packets (b) according to a pre-determined pattern (S311).

[75] The RS encoding unit 520 appends parities of predetermined bytes to the randomized normal data packets (a) and robust data packets (b) (S313).

[76] The storage unit 531 stores the normal data packets (a)(g) and the robust data packets (b)(i) to which parities have been appended (S315).

[77] The N/R TRS encoding unit 532 generates parity packets with respect to the normal data packets (a)(g) and robust data packets (b)(i) that have been stored in the storage unit 531 (S317). In here, the process for generating the parity packets can be separated into a process for generating the parity packets with respect to the data packets except for the parities and a process for generating the parity packets with respect to the data packets including the parities.

[78] In case of the data packets except for the parities, the N/R TRS encoding unit 532

applies the transversal encoding only to the data portions except for the parities (g)(i) with respect to the data packets stored in the storage unit 531 in order to generate the parity packets. As shown in FIG. 4 and FIG. 5, the N/R TRS encoding unit 532 generates the normal parity packets (c) and the robust parity packets (d) with respect to the normal data packets (a) and the robust data packets (b), or generates the parity packets (D) with respect to the normal data packets (a) and the robust data packets (d).

[79] In case of the data packets including the parities, the N/R TRS encoding unit 532 applies the transversal encoding to the data packets including the parities (g)(i), and generates the parity packets (S317). That is, as shown in FIGS. 4 and 5, the N/R TRS encoding unit 532 generates the normal parity packet (c)(h) and robust parity packet (d)(j) with respect to the normal data packet (a)(g) and robust data packet (b)(i), or generates the parity packets (D)(J) with respect to the normal data packets (a)(g) and the robust data packets (d)(i). Next, the TRS encoding part 530 re-arranges the generated parity packets in predetermined bytes. For example, the TRS encoding part 530 re-arranges a generated parity packets of 207 bytes into parity packets of 187 bytes.

[80] The PID insertion unit 533 inserts headers (PIDs) into the generated parity packets (S319). As shown in FIG. 4 and FIG. 5, the PID insertion unit 533 inserts the headers (PIDs) (e)(f) into the generated normal packets (c)(d), or, as shown in FIG. 6, the PID insertion unit 533 inserts the headers (PIDs) (F) into the generated parity packets (D).

[81] As above, the parity packets generated from the TRS encoding part 530 are fed back to the randomization unit 510 for randomization (S321), and the RS encoding unit 520 appends parities of predetermined bytes to the randomized parity packets (S323). As shown in FIG. 4 and FIG. 5, the parities (h)(j) of 20 bytes are appended to the randomized normal parity packets (c) and robust parity packets (d), or, as shown in FIG. 6, the parities (J) of 20 bytes are appended to the randomized parity packets (D).

[82] The parity packets to which the parities of predetermined bytes are appended in the RS encoding unit 520 are stored in the storage unit 531 (S325). That is, the storage unit 531 stores one field data as shown in FIG. 4 through FIG. 6.

[83] The packet format part 550 splits input packets into the normal data and the robust data according to the controls of the system control unit 580, and processes data according to respective packet formats (S327).

[84] The interleaving unit 560 interleaves the packets processed according to the data formats for re-arrangement in byte (S328), and the Trellis encoding unit 570 applies the Trellis encoding to the interleaved data for re-arrangement in bit (S320).

[85] As aforementioned, the error correction encoding apparatuses for dual-stream broadcasts according to the first to third embodiments of the present invention have been described to be provided with the TRS encoding unit having the storage unit, N/R TRS encoding unit, and PID insertion unit, but the apparatuses can be a TRS encoding part 610 as shown in FIG. 12.

[86] As shown in FIG. 12, the TRS encoding part 610 has a storage unit 611 for storing normal data packets and robust data packets, an N-TRS encoding unit 612 for applying the transversal encoding to the normal data packets and generating normal parity packets, an N-PID insertion unit 613 for inserting headers (PIDs) into the normal parity packets, an R-TRS encoding unit 614 for encoding the transversal encoding to the robust data packets and generating the robust parity packets, and an R-PID insertion unit 615 for inserting headers (PIDs) into the robust parity packets.

[87] That is, the TRS encoding parts according to the first to third embodiments shown in FIG. 3, FIG. 7, and FIG. 10 can be replaced with the TRS encoding part 610 shown in FIG. 12.

[88] FIG. 13 is a block diagram for schematically showing an error correction decoding apparatus for dual-stream corresponding to the error correction encoding apparatus for dual stream according to an embodiment of the present invention.

[89] The error correction decoding apparatus has a Trellis decoding unit 711, a de-interleaving unit 721, a packet re-format part 730, an RS decoding unit 741, a de-randomization/randomization unit 743, a TRS decoding part 750, and de-randomization unit 761.

[90] The Trellis decoding unit 711 and the de-interleaving unit 721 applies the Trellis decoding and deinterleaving corresponding to the Trellis encoding and interleaving applied at the transmission side.

[91] The packet re-format part 730 has a de-multiplexer 731, an R packet processor 732, and a multiplexer 733, splits input packets into normal data and robust data according to the controls of the system control unit 770, and processes data corresponding to respective data formats.

[92] The de-multiplexer 731 splits packets in correspondence with formats of the packets split at the transmission side, as shown in FIG. 4 and FIG. 6, for example, according to the controls of the system control unit 770.

[93] The de-multiplexer 731 outputs to the multiplexer 733 the packets that have been split into the normal data, and the R packet processor 732 processes the packets that have been split into the robust data into the normal data according to certain ratios, for

example, ½ and ¼, of the transmission side, and outputs the normal data to the multiplexer 733.

[94] The RS decoding unit 741 corrects errors in the row direction of the field data by use of the parities of predetermined bytes included in the packets.

[95] The de-randomization/randomization unit 743 randomizes packets according to a predetermined pattern. If the TRS encoding unit is used before the randomization unit as in the first embodiment, the de-randomization/randomization unit 743 at the transmission side randomizes all the data and parity packets, and, if the TRS encoding unit is used after the randomization unit as in the second and third embodiments, the de-randomization/randomization unit 743 randomizes only the parity packets.

[96] The TRS decoding part 750 has a storage unit 751 and an N/R TRS decoding unit 753, and corrects packet errors in the column direction by use of parity packets. The storage unit 751 stores data error-corrected at the RS decoding unit 741 and N/R TRS decoding unit 753, information of whether or not error has been corrected, and so on.

[97] The de-randomization unit 761 de-randomizes according to a predetermined pattern the data packets that have been error-corrected in the row direction in the RS decoding unit 741.

[98] In the error correction decoding apparatus for dual stream according to the present invention as above, the TRS decoding part 750 has been described to include the storage unit 751 and the N/R TRS decoding unit 753, but the TRS decoding part 810 as shown in FIG. 14 can be used for the N/R TRS decoding part 750.

[99] As shown in FIG. 14, the TRS decoding part 810 has a storage unit 811 for storing data packets and parity packets, an N-TRS decoding unit 813 for applying the transversal decoding unit 813 to normal data packets by use of normal parity packets, and an R-TRS decoding unit 815 for applying the transversal decoding to robust data packets by use of robust parity packets. That is, the TRS decoding part 750 as shown in FIG. 13 can be replaced with the TRS decoding part 810 as shown in FIG. 14.

[100] FIG. 15 is a flow chart for showing an error correction decoding process for the error correction encoding apparatus according to the first embodiment of FIG. 3.

[101] The Trellis decoding unit 711 and the de-interleaving unit 721 applies the Trellis encoding used at the transmission side, and applies the Trellis decoding and de-interleaving corresponding to the interleaving at the transmission side (S411).

[102] The packet re-format part 730 splits the de-interleaved packets into normal data packets and robust data packets, and processes data corresponding to respective packet formats (S413).

[103] The RS decoding unit 741 uses 20-byte parities (g)(h)(i)(j) included in the packets to correct packet errors in the row direction of field data (S415).

[104] The de-randomization/randomization unit 743 de-randomizes all the data packets and parity packets (S417). In here, in the error correction encoding of the first embodiment, the parity packets generated from the TRS encoding part 310 are de-randomized packets generated based on the de-randomized data packets since the TRS encoding part 310 is disposed before the randomization unit 320. Therefore, the de-randomization/randomization unit 743 de-randomizes all the data packets and parity packets.

[105] The storage unit 751 stores data error-corrected in the row direction in the RS decoding unit 743 and information on whether errors have been corrected (S419).

[106] The N/R TRS decoding unit 753 uses the de-randomized parity packets stored in the storage unit 751 to correct errors in the column direction with respect to the de-randomized data packets (S421).

[107] Next, the data stored in the storage unit 751 is updated based on the data error-corrected in the column direction in the N/R TRS decoding unit 753 and the information on whether the errors have been corrected (S423).

[108] The de-randomization/randomization unit 743 re-randomizes the de-randomized data packets and parity packets stored in the storage unit 751 (S425). In here, the RS encoding unit 330 of the error correction encoding apparatus of FIG. 3 randomizes the data packets and the parity packets before the RS decoding unit 741 applies the RS decoding since parities have been appended to the randomized data packets and parity packets.

[109] The RS decoding unit 741 uses 20-byte parities to correct errors once more with respect to the randomized data packets and parity packets (S427).

[110] The de-randomized unit 761 de-randomizes the error-corrected data according to a predetermined pattern, so the reception system terminates its error correction (S429).

[111] FIG. 16 is a flow chart for showing an error correction decoding processor for the error correction decoding apparatuses according to the second and third embodiments as shown in FIG. 8 and FIG. 10, and description will be made on an error correction decoding process for the second and third embodiments with reference through FIG. 16.

[112] The Trellis decoding unit 711 and the de-interleaving unit 721 applies the Trellis encoding used at the transmission side, and applies the Trellis decoding and de-interleaving corresponding to the interleaving at the transmission side(S511).

[113] The packet re-format part 730 splits the de-interleaved packets into normal data packets and robust data packets, and processes data corresponding to respective packet formats (S513).

[114] The RS decoding unit 741 uses 20-byte parities included in the packets to correct packet errors in the row direction of field data (S515).

[115] The de-randomization/randomization unit 743 de-randomizes only the parity packets (S517). In here, the de-randomization/randomization unit 743 de-randomizes only the parity packets since the TRS encoding part of the error correction encoding apparatuses shown in FIG. 8 and FIG. 10 is disposed behind the randomization unit and the parity packets generated from the TRS encoding part are de-randomized packets generated based on the randomized data packets.

[116] The storage unit 751 stores data error-corrected in the row direction in the RS decoding unit 743 and information on whether errors have been corrected (S519).

[117] The N/R TRS decoding unit 753 uses the de-randomized parity packets stored in the storage unit 751 to correct errors in the column direction with respect to the randomized data packets (S521).

[118] Next, the N/R TRS decoding unit 753 updates the data stored in the storage unit 751 based on the data error-corrected in the column direction and the information on whether the errors have been corrected (S523).

[119] The de-randomization/randomization unit 743 re-randomizes the de-randomized data packets stored in the storage unit 751 (S525). In here, the RS encoding unit of the error correction encoding apparatuses shown in FIG. 8 and FIG. 10, randomizes the de-randomized parity packets stored in the storage unit 751 before the RS decoding unit 741 applies the RS decoding since parities are appended to the randomized data packets and parity packets.

[120] The RS decoding unit 741 uses 20-byte parities to correct errors once more with respect to the randomized data packets and parity packets (S527).

[121] The de-randomized unit 761 de-randomizes the error-corrected data according to a predetermined pattern, so the reception system terminates its error correction (S529).

Industrial Applicability

[122] The present invention relates to an error correction encoding/decoding apparatus for American ATSC digital terrestrial broadcast reception/transmission systems, and more particularly to a robust error correction encoding/decoding apparatus and method for digital dual-stream broadcast reception/transmission systems which split data into normal and robust data for processing, receiving, and transmitting the data.

Claims

[1] 1. An error correction encoding apparatus for digital dual-stream broadcast transmission systems, comprising:
a Transversal Reed-Solomon(TRS) encoding part for applying the transversal encoding to normal data packets and robust data packets and appending parity packets;
a randomization unit for randomizing the data packets and the parity packets according to a predetermined pattern;
an RS encoding unit for encoding the randomized data packets and parity packets and appending parities of predetermined bytes;
a packet format unit for splitting the data packets and the parity packets into normal data and robust data and processing the data according to respective data formats; and
a system control unit for controlling the packet format unit to split into the normal data and the robust data and process the data packets and the parity packets.

[2] 2. The error correction decoding apparatus as claimed in claim 1, wherein the TRS encoding part includes:
a storage unit for storing the data packets and the parity packets;
an N/R TRS encoding unit for applying the transversal encoding to the data packets and generating the parity packets; and
a PID insertion unit for inserting packet headers to the parity packets.

[3] 3. The error correction decoding apparatus as claimed in claim 1, wherein the TRS encoding part includes:
a storage unit for storing the normal data packets, robust data packets, and parity packets;
an N-TRS encoding unit for generating parity packets for the normal data packets;
an N-PID insertion unit for inserting packet headers into the parity packets of the normal data packets;
an R-TRS encoding unit for generating parity packets for the robust data packets; and
an R-PID insertion unit for inserting packet headers into the parity packets of the robust data packets.

[4] 4. The error correction encoding apparatus as claimed in claim 1, wherein the TRS encoding part generates parity packets for the normal data packets and the robust data packets, respectively.

[5] 5. The error correction encoding apparatus as claimed in claim 1, wherein the TRS encoding part generates parity packets for the normal data packets, the robust data packets, and entire data packets.

[6] 6. The error correction encoding apparatus as claimed in claim 1, wherein the packet format unit includes:

a demultiplexer for splitting the normal data packets, robust data packets, and parity packets into the normal data and the robust data according to controls of the system control unit; and

an R packet processor for carrying out a robust data process with respect to the split robust data.

[7] 7. The error correction encoding apparatus as claimed in claim 6, wherein the system control unit controls the demultiplexer to split the normal data packets and the parity packets of the normal data packets into the normal data, and to split the robust data packets and the parity packets of the robust data packets into the robust data.

[8] 8. The error correction encoding apparatus as claimed in claim 6, wherein the system control unit controls the demultiplexer to split the normal data packets into the normal data, and to split the robust data packets and the parity packets into the robust data.

[9] 9. An error correction encoding method for digital dual stream broadcast transmission systems, comprising steps of:

(a) applying transversal encoding to normal data packets and robust data packets and appending parity packets;

(b) randomizing the data packets and the parity packets according to a pre-determined pattern;

(c) encoding the randomized data packets and parity packets and appending parities of predetermined bytes; and

(d) splitting the data packets and the parity packets into normal data and robust data, and processing the data according to respective data formats.

[10] 10. The error correction encoding method as claimed in claim 9, wherein the step (a) includes steps of:

(a-1) applying the transversal encoding to the data packets and generating the

parity packets;

(a-2) inserting packet headers into the parity packets; and

(a-3) storing the data packets and the parity packets.

[11] 11. The error correction encoding method as claimed in claim 9, wherein the step (a) generates parity packets for the normal data packets and the robust data packets, respectively.

[12] 12. The error correction encoding method as claimed in claim 9, wherein the step (a) generates parity packets for the normal data packets, the robust data packets, and entire data packets.

[13] 13. The error correction encoding method as claimed in claim 9, wherein the step (d) includes steps of:

(d-1) splitting the normal data packets, robust data packets, and parity packets into the normal data and the robust data according to a predetermined control signal; and

(d-2) processing the packets split into the normal data and the robust data according to respective data formats.

[14] 14. The error correction encoding method as claimed in claim 13, wherein the step (d-1) splits the normal data packets and the parity packets of the normal data packets into the normal data, and splits the robust data packets and the parity packets of the robust data packets into the robust data.

[15] 15. The error correction encoding method as claimed in claim 13, wherein the step (d-1) splits the normal data packets into the normal data, and splits the robust data packets and the parity packets into the robust data.

[16] 16. An error correction encoding apparatus for digital dual-stream broadcast transmission systems, comprising:

a randomization unit for randomizing normal data packets and robust data packets according to a predetermined pattern;

a TRS encoding part for applying the transversal encoding to the randomized normal data packets and robust data packets and appending parity packets;

an RS encoding unit for appending parities of predetermined bytes to the data packets and parity packets;

a packet format unit for splitting the data packets and the parity packets into normal data and robust data and processing the data according to respective data formats; and

a system control unit for controlling the packet format unit to split into the

normal data and the robust data and process the data packets and the parity packets, wherein the randomization unit randomizes the parity packets according to a predetermined pattern.

[17] 17. The error correction decoding apparatus as claimed in claim 16, wherein the TRS encoding part includes:

a storage unit for storing the data packets and the parity packets;

an N/R TRS encoding unit for applying the transversal encoding to the data packets and generating the parity packets; and

a PID insertion unit for inserting packet headers to the parity packets.

[18] 18. The error correction decoding apparatus as claimed in claim 16, wherein the TRS encoding part includes:

a storage unit for storing the normal data packets, robust data packets, and parity packets;

an N-TRS encoding unit for generating parity packets for the normal data packets;

an N-PID insertion unit for inserting packet headers into the parity packets of the normal data packets;

an R-TRS encoding unit for generating parity packets for the robust data packets; and

an R-PID insertion unit for inserting packet headers into the parity packets of the robust data packets.

[19] 19. The error correction encoding apparatus as claimed in claim 16, wherein the TRS encoding part generates parity packets for the normal data packets and the robust data packets, respectively.

[20] 20. The error correction encoding apparatus as claimed in claim 16, wherein the TRS encoding part generates parity packets for the normal data packets, the robust data packets, and entire data packets.

[21] 21 The error correction encoding apparatus as claimed in claim 16, wherein the packet format unit includes:

a demultiplexer for splitting the normal data packets, robust data packets, and parity packets into the normal data and the robust data according to controls of the system control unit; and

an R packet processor for carrying out a robust data process with respect to the split robust data.

[22] 22. The error correction encoding apparatus as claimed in claim 21, wherein the

system control unit controls the demultiplexer to split the normal data packets and the parity packets of the normal data packets into the normal data, and to split the robust data packets and the parity packets of the robust data packets into the robust data.

[23] 23. The error correction encoding apparatus as claimed in claim 21, wherein the system control unit controls the demultiplexer to split the normal data packets into the normal data, and to split the robust data packets and the parity packets into the robust data.

[24] 24. An error correction encoding method for digital dual stream broadcast transmission systems, comprising steps of:

(a) randomizing normal data packets and robust data packets according to a pre-determined pattern;

(b) appending parity packets to the randomized normal data packets and robust data packets;

(c) randomizing the parity packets according to a predetermined pattern;

(d) appending parities of predetermined bytes to the data packets and the parity packets; and

(e) splitting the data packets and the parity packets into normal data and robust data, and processing the data according to respective data formats.

[25] 25. The error correction encoding method as claimed in claim 24, wherein the step (b) includes steps of:

(b-1) applying the transversal encoding to the data packets and generating the parity packets;

(b-2) inserting packet headers into the parity packets; and

(b-3) storing the data packets and the parity packets.

[26] 26. The error correction encoding method as claimed in claim 24, wherein the step (b) generates parity packets for the normal data packets and the robust data packets, respectively.

[27] 27. The error correction encoding method as claimed in claim 24, wherein the step (b) generates parity packets for the normal data packets, the robust data packets, and entire data packets.

[28] 28. The error correction encoding method as claimed in claim 24, wherein the step (e) includes steps of:

(e-1) splitting the normal data packets, robust data packets, and parity packets into the normal data and the robust data according to a predetermined control

signal; and

(e-2) processing the packets split into the normal data and the robust data according to respective data formats.

[29] 29. The error correction encoding method as claimed in claim 28, wherein the step (e-1) splits the normal data packets and the parity packets of the normal data packets into the normal data, and splits the robust data packets and the parity packets of the robust data packets into the robust data.

[30] 30. The error correction encoding method as claimed in claim 28, wherein the step (e-1) splits the normal data packets into the normal data, and splits the robust data packets and the parity packets into the robust data.

[31] 31. An error correction encoding apparatus for digital dual-stream broadcast transmission systems, comprising:

a randomization unit for randomizing normal data packets and robust data packets according to a predetermined pattern;

an RS encoding unit for appending parities of predetermined bytes to the data packets;

a TRS encoding part for applying the transversal encoding to the data packets and appending parity packets; and

a packet format unit for splitting the data packets and the parity packets into normal data and robust data and processing the data according to respective data formats,

wherein the randomization unit randomizes the parity packets according to the predetermined pattern and the RS encoding unit appends the parity of pre-determined bytes to the randomized parity packets.

[32] 32. The error correction decoding apparatus as claimed in claim 31, wherein the TRS encoding part includes:

a storage unit for storing the data packets and the parity packets;

an N/R TRS encoding unit for applying the transversal encoding to the data packets excluding parities and generating the parity packets; and

a PID insertion unit for inserting packet headers to the parity packets.

[33] 33. The error correction decoding apparatus as claimed in claim 32, wherein the N/R TRS encoding unit applies the transversal encoding to the data packets including the parities to append parity packets, and re-arranges the parity packets in predetermined bytes.

[34] 34. The error correction decoding apparatus as claimed in claim 31, wherein the

TRS encoding part includes:

a storage unit for storing the normal data packets, robust data packets, and parity packets;

an N-TRS encoding unit for generating parity packets for the normal data packets excluding the parities;

an N-PID insertion unit for inserting packet headers into the parity packets of the normal data packets;

an R-TRS encoding unit for generating parity packets for the robust data packets excluding the parities; and

an R-PID insertion unit for inserting packet headers into the parity packets of the robust data packets.

[35] 35. The error correction encoding apparatus as claimed in claim 34, wherein the N-TRS encoding unit generates the parity packets for the normal data packets including the parities and re-arranges the generated parity packets in pre-determined byte, and the R-TRS encoding unit generates the parity packets for the robust data packets including the parities and re-arranges the generated parity packets in predetermined bytes.

[36] 36. The error correction encoding apparatus as claimed in claim 31, wherein the TRS encoding part generates parity packets for the normal data packets and the robust data packets, respectively.

[37] 37. The error correction encoding apparatus as claimed in claim 31, wherein the TRS encoding part generates parity packets for the normal data packets, the robust data packets, and entire data packets.

[38] 38. The error correction encoding apparatus as claimed in claim 31, wherein the packet format unit includes:

a demultiplexer for splitting the normal data packets, robust data packets, and parity packets into the normal data and the robust data according to controls of the system control unit; and

an R packet processor for carrying out a robust data process with respect to the split robust data.

[39] 39. The error correction encoding apparatus as claimed in claim 38, wherein the system control unit controls the demultiplexer to split the normal data packets and the parity packets of the normal data packets into the normal data, and to split the robust data packets and the parity packets of the robust data packets into the robust data.

[40] 40. The error correction encoding apparatus as claimed in claim 38, wherein the system control unit controls the demultiplexer to split the normal data packets into the normal data, and to split the robust data packets and the parity packets into the robust data.

[41] 41. An error correction encoding method for digital dual-stream broadcast transmission systems, comprising steps of:

(a) randomizing normal data packets and robust data packets according to a predetermined pattern;

(b) appending parities of predetermined bytes to the randomized data packets;

(c) applying the transversal encoding to the data packets excluding the parities to append parity packets;

(d) randomizing the parity packets according to the predetermined pattern;

(e) appending parities of predetermined bytes to the randomized parity packets; and

(f) splitting the data packets and the parity packets into normal data and robust data, and processing the data according to respective data formats.

[42] 42. The error correction encoding method as claimed in claim 41, wherein the step (d) includes steps of:

(d-1) applying the transversal encoding to the data packets excluding the parities and generating the parity packets; and

(d-2) inserting packet headers into the parity packets.

[43] 43. The error correction encoding method as claimed in claim 42, wherein the step (d-1) applies the transversal encoding to the data packets including the parities to append the parity packets, and re-arranges the parity packets in predetermined bytes.

[44] 44. The error correction encoding method as claimed in claim 41, wherein the step (d) generates parity packets for the normal data packets and the robust data packets, respectively.

[45] 45. The error correction encoding method as claimed in claim 41, wherein the step (d) generates parity packets for the normal data packets, the robust data packets, and entire data packets.

[46] 46. The error correction encoding method as claimed in claim 41, wherein the step (f) includes steps of:

(f-1) splitting the normal data packets, robust data packets, and parity packets into the normal data and the robust data according to a predetermined control

signal; and

(f-2) processing the packets split into the normal data and the robust data according to respective data formats.

[47] 47. The error correction encoding method as claimed in claim 46, wherein the step (f-1) splits the normal data packets and the parity packets of the normal data packets into the normal data, and splits the robust data packets and the parity packets of the robust data packets into the robust data.

[48] 48. The error correction encoding method as claimed in claim 46, wherein the step (f-1) splits the normal data packets into the normal data, and splits the robust data packets and the parity packets into the robust data.

[49] 49. An error correction decoding apparatus for digital dual-stream broadcast reception systems, comprising:

a packet re-format unit for splitting input data packets and parity packets into normal data and robust data and processing data according to respective data formats;

an RS decoding unit for correcting errors of the packets by use of parities of pre-determined bytes included in the packets;

a de-randomization/randomization unit for de-randomizing the packets corresponding to error correction encoding; and

a TRS decoding part for correcting errors of the packets by use of the parity packets, wherein the de-randomization/randomization unit randomizes the packets error-corrected in the TRS decoding part.

[50] 50. The error correction decoding apparatus as claimed in claim 49, wherein the TRS decoding part includes:

a storage unit for storing the error-corrected packets by use of the parities; and

an N/R TRS decoding unit for correcting errors of the packets by use of the parity packets, the N/R TRS decoding unit storing the error-corrected packets in the storage unit.

[51] 51. The error correction decoding apparatus as claimed in claim 49, wherein the TRS decoding part includes:

a storage unit for storing the error-corrected packets by use of the parities;

an N-TRS decoding unit for correcting errors of normal data packets by use of the parity packets of the normal data packets; and

an R-TRS decoding unit for correcting errors of robust data packets by use of the parity packets of the robust data packets, the N-TRS decoding unit and the R-

TRS decoding unit storing the error-corrected packets in the storage unit.

[52] 52. The error correction decoding apparatus as claimed in claim 49, wherein the RS decoding part corrects the errors once more by use of parities of the packets error-corrected in the TRS decoding part.

[53] 53. The error correction decoding apparatus as claimed in claim 49, wherein the de-randomization/randomization unit de-randomizes all the data packets and parity packets if the de-randomization/randomization unit carries out the randomization after the Trellis encoding in error correction encoding at a transmission side.

[54] 54. The error correction decoding apparatus as claimed in claim 49, wherein the de-randomization/randomization unit de-randomizes only the parity packets if the de-randomization/randomization unit applies the TRS encoding after the randomization in the error correction encoding at a transmission side.

[55] 55. An error correction decoding method for digital dual-stream broadcast reception systems, comprising steps of:

(a) splitting input data packets and parity packets into normal data and robust data and processing data according to respective data formats;

(b) correcting errors of the packets by use of parities of predetermined bytes included in the packets;

(c) de-randomizing the packets corresponding to error correction encoding; and

(d) correcting errors of the packets by use of the parity packets; and

(e) randomizing the error-corrected packets by use of the parity packets.

[56] 56. The error correction decoding method as claimed in claim 55, wherein the step (d) includes steps of:

(d-1) storing the error-corrected packets by use of the parities; and

(d-2) correcting errors of the packets by use of the parity packets; and

(d-3) storing the error-corrected packets by use of the parity packets.

[57] 57. The error correction decoding method as claimed in claim 55, further comprising a step of (f) correcting errors once more by use of the parities of the packets error-corrected by using the parity packets.

[58] 58. The error correction decoding method as claimed in claim 55, wherein the step (c) de-randomizes all the data packets and parity packets if the randomization is carried out after the Trellis encoding in error correction encoding.

[59] 59. The error correction decoding method as claimed in claim 55, wherein the step (c) de-randomizes only the parity packets if the TRS encoding is applied

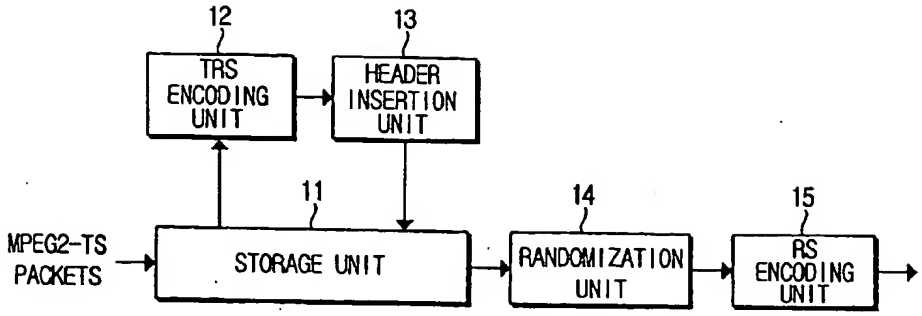
after the randomization in the error correction encoding.

[60] 60. An error correction encoding apparatus for digital dual-stream broadcast transmission systems, comprising:
a TRS encoding part for applying the transversal encoding to normal data packets and robust data packets, and appending parity packets;
an RS encoding unit for encoding the randomized data packets and parity packets, and appending parities of predetermined bytes; and
a packet format unit for splitting the data packets and the parity packets into normal data and robust data, and processing data according to respective data formats.

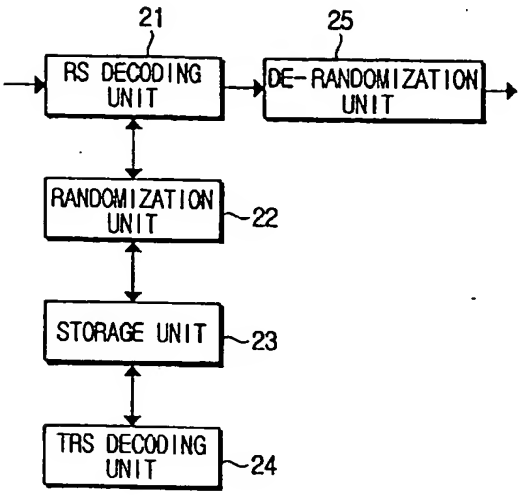
[61] 61. The error correction encoding apparatus as claimed in claim 60, further comprising a randomization for randomizing the data packets and the parity packets according to a predetermined pattern.

[62] 62. The error correction encoding apparatus as claimed in claim 60, further comprising a system control unit for controlling the packet format unit to split the data packets and the parity packets into the normal data and the robust data and process the data.

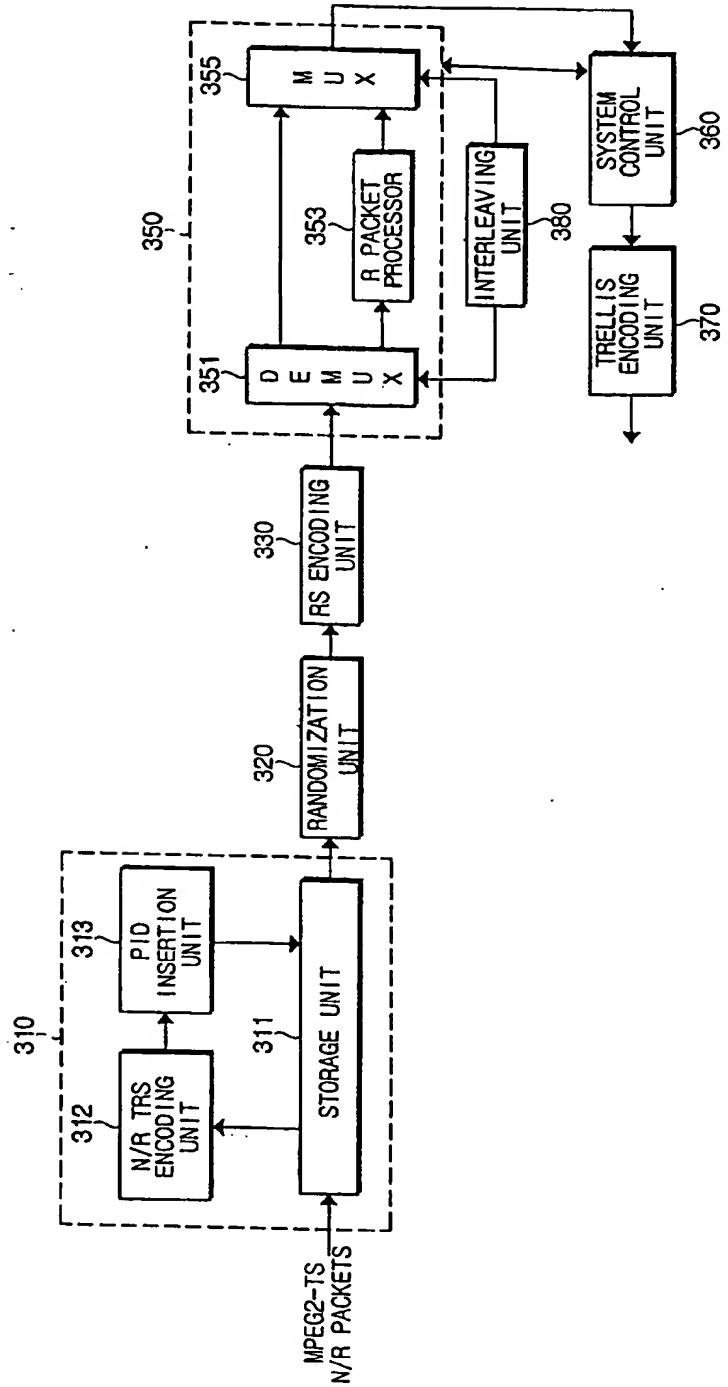
[Fig. 1]


12
13
TRS ENCODING UNIT
HEADER INSERTION UNIT
11
14
15
MPEG2-TS PACKETS
STORAGE UNIT
RANDOMIZATION UNIT
RS ENCODING UNIT

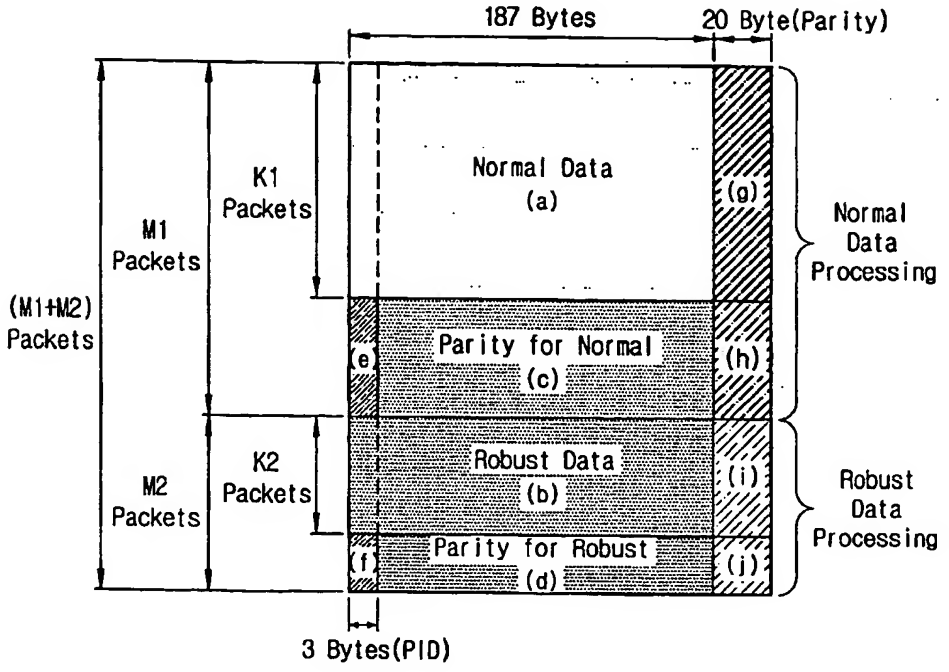
[Fig. 2]


21
25
RS DECODING UNIT
DE-RANDOMIZATION UNIT
RANDOMIZATION UNIT
22
STORAGE UNIT
23
TRS DECODING UNIT
24

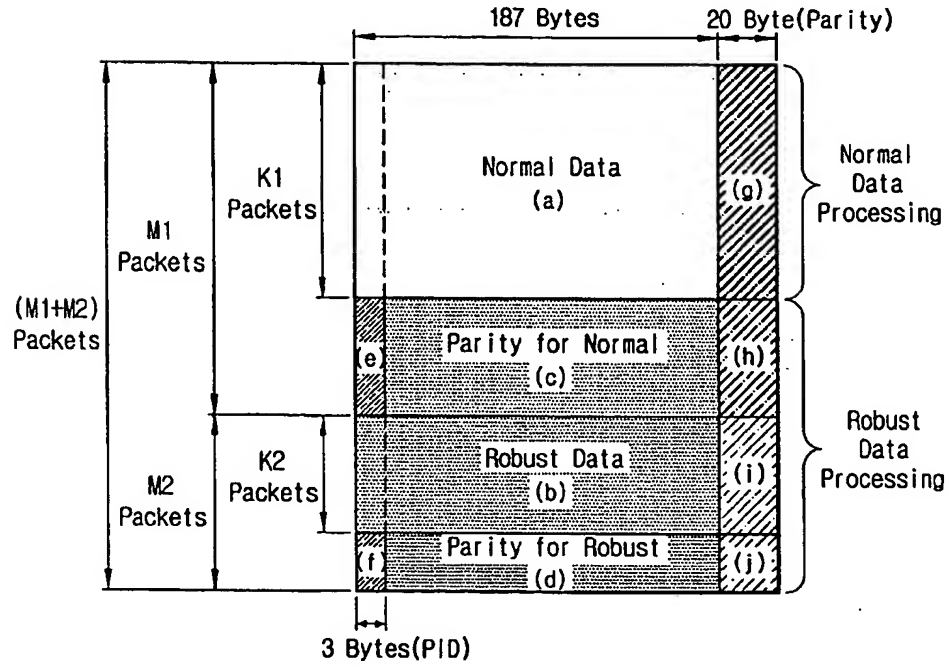
[Fig. 3]


MPEG2-TS N/R PACKETS
310
313
PID INSERTION UNIT
312
N/R TRS ENCODING UNIT
311
STORAGE UNIT
320
RANDOMIZATION UNIT
330
RS ENCODING UNIT
350
351
DEMUX
353
R PACKET PROCESSOR
355
MUX
380
INTERLEAVING UNIT
360
SYSTEM CONTROL UNIT
370
TRELLIS ENCODING UNIT

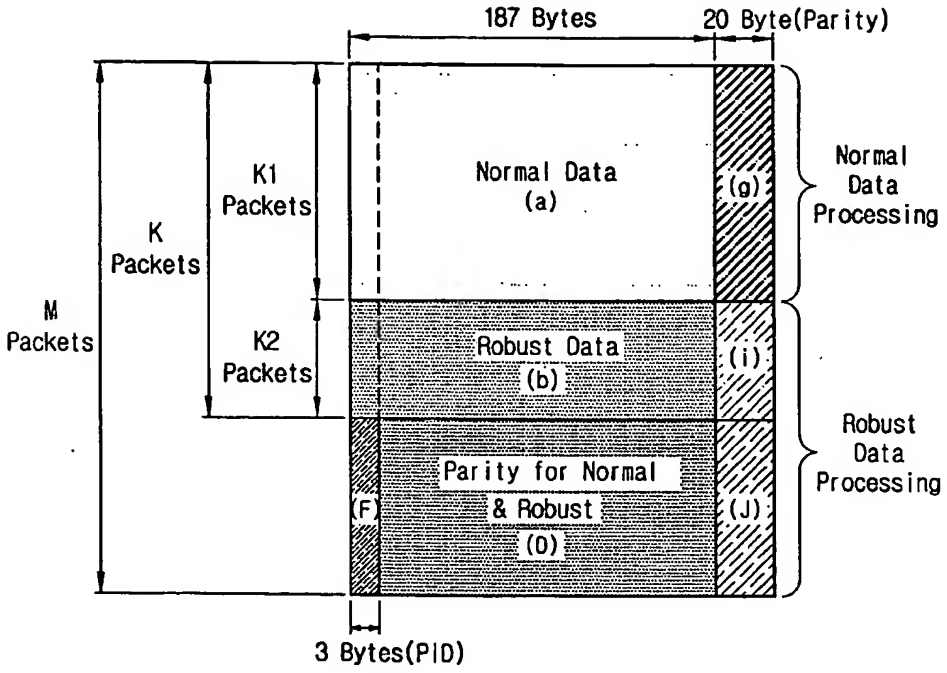
[Fig. 4]


187 Bytes
20 Byte(Parity)
K1 Packets
M1 Packets
(M1+M2) Packets
K2 Packets
M2 Packets
Normal Data (a)
Parity for Normal (c)
Robust Data (b)
Parity for Robust (d)
(e)
(f)
(g)
(h)
(i)
(j)
Normal Data Processing
Robust Data Processing
3 Bytes(PID)

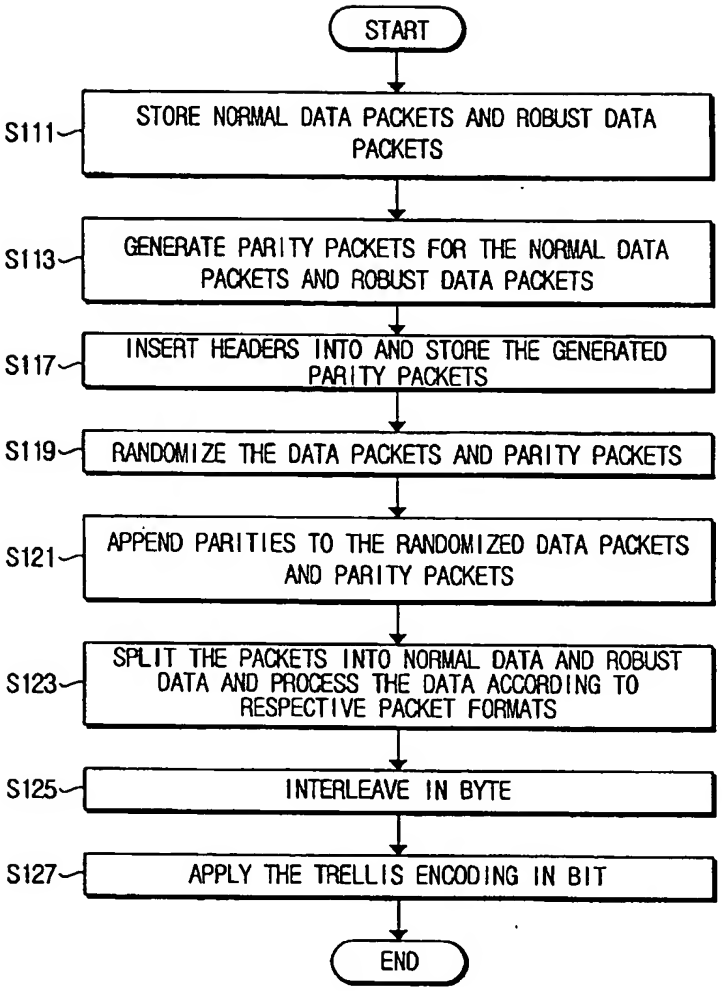
[Fig. 5]


187 Bytes
20 Byte(Parity)
K1 Packets
M1 Packets
(M1+M2) Packets
K2 Packets
M2 Packets
Normal Data (a)
Parity for Normal (c)
Robust Data (b)
Parity for Robust (d)
(e)
(f)
(g)
(h)
(i)
(j)
Normal Data Processing
Robust Data Processing
3 Bytes(PID)

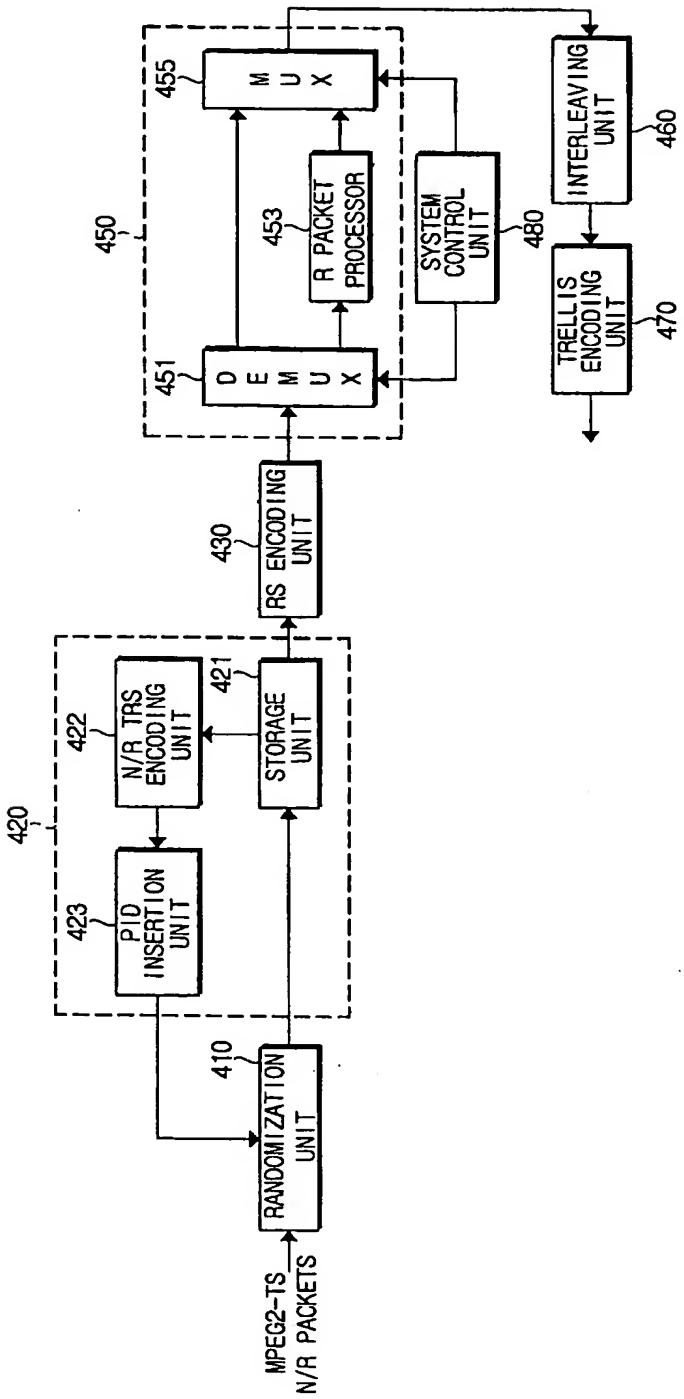
[Fig. 6]


187 Bytes
20 Byte(Parity)
Normal Data
(a)
(g)
Normal
Data
Processing
K1
Packets
K
Packets
M
Packets
K2
Packets
Robust Data
(b)
(i)
Parity for Normal
& Robust
(D)
(F)
(J)
Robust
Data
Processing
3 Bytes(PID)

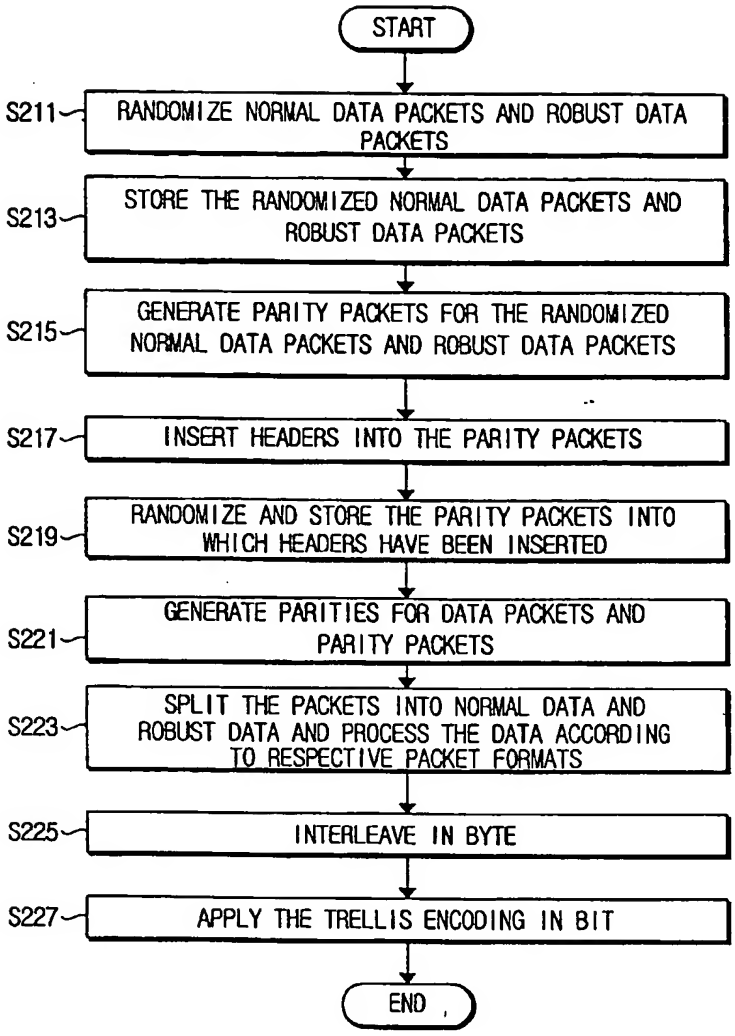
[Fig. 7]


START
S111
STORE NORMAL DATA PACKETS AND ROBUST DATA PACKETS
S113
GENERATE PARITY PACKETS FOR THE NORMAL DATA PACKETS AND ROBUST DATA PACKETS
S117
INSERT HEADERS INTO AND STORE THE GENERATED PARITY PACKETS
S119
RANDOMIZE THE DATA PACKETS AND PARITY PACKETS
S121
APPEND PARITIES TO THE RANDOMIZED DATA PACKETS AND PARITY PACKETS
S123
SPLIT THE PACKETS INTO NORMAL DATA AND ROBUST DATA AND PROCESS THE DATA ACCORDING TO RESPECTIVE PACKET FORMATS
S125
INTERLEAVE IN BYTE
S127
APPLY THE TRELLIS ENCODING IN BIT
END

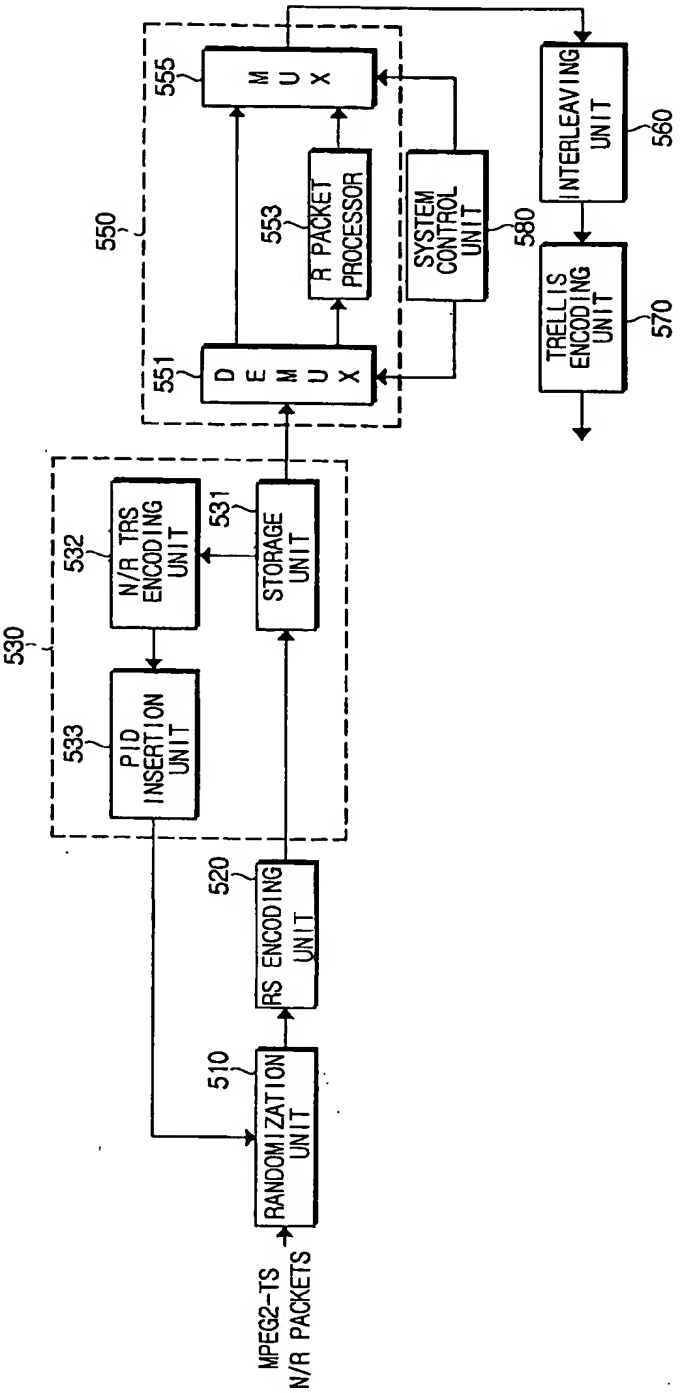
[Fig. 8]


MPEG2-TS
N/R PACKETS
RANDOMIZATION UNIT
410
PID INSERTION UNIT
423
N/R TRS ENCODING UNIT
422
STORAGE UNIT
421
420
RS ENCODING UNIT
430
DEMUX
451
R PACKET PROCESSOR
453
MUX
455
450
SYSTEM CONTROL UNIT
480
INTERLEAVING UNIT
460
TRELLIS ENCODING UNIT
470

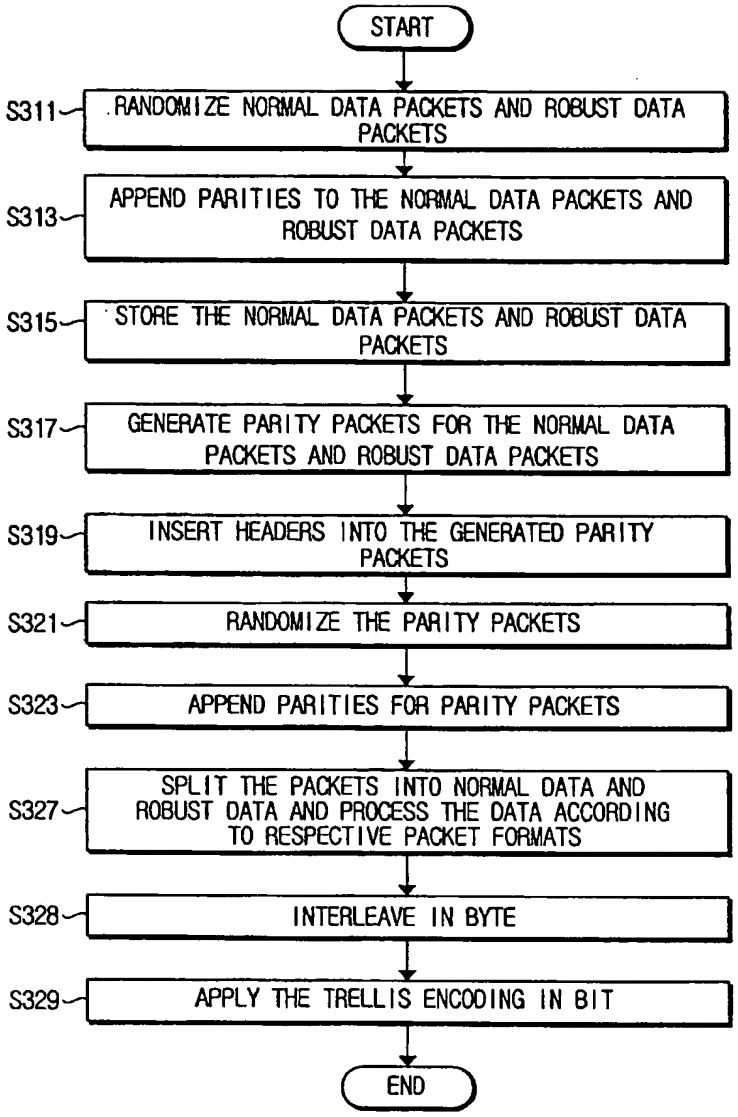
[Fig. 9]


START
S211
RANDOMIZE NORMAL DATA PACKETS AND ROBUST DATA PACKETS
S213
STORE THE RANDOMIZED NORMAL DATA PACKETS AND ROBUST DATA PACKETS
S215
GENERATE PARITY PACKETS FOR THE RANDOMIZED NORMAL DATA PACKETS AND ROBUST DATA PACKETS
S217
INSERT HEADERS INTO THE PARITY PACKETS
S219
RANDOMIZE AND STORE THE PARITY PACKETS INTO WHICH HEADERS HAVE BEEN INSERTED
S221
GENERATE PARITIES FOR DATA PACKETS AND PARITY PACKETS
S223
SPLIT THE PACKETS INTO NORMAL DATA AND ROBUST DATA AND PROCESS THE DATA ACCORDING TO RESPECTIVE PACKET FORMATS
S225
INTERLEAVE IN BYTE
S227
APPLY THE TRELLIS ENCODING IN BIT
END

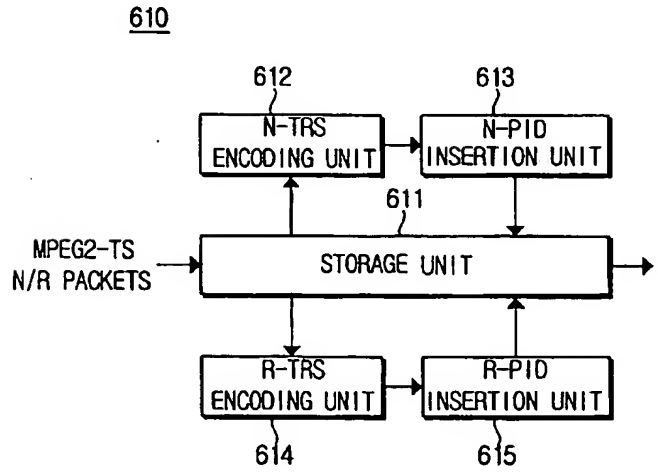
[Fig. 10]


MPEG2-TS
N/R PACKETS
RANDOMIZATION UNIT
510
RS ENCODING UNIT
520
530
PID INSERTION UNIT
533
N/R TRS ENCODING UNIT
532
STORAGE UNIT
531
550
DEMUX
551
R PACKET PROCESSOR
553
MUX
555
SYSTEM CONTROL UNIT
580
TRELLIS ENCODING UNIT
570
INTERLEAVING UNIT
560

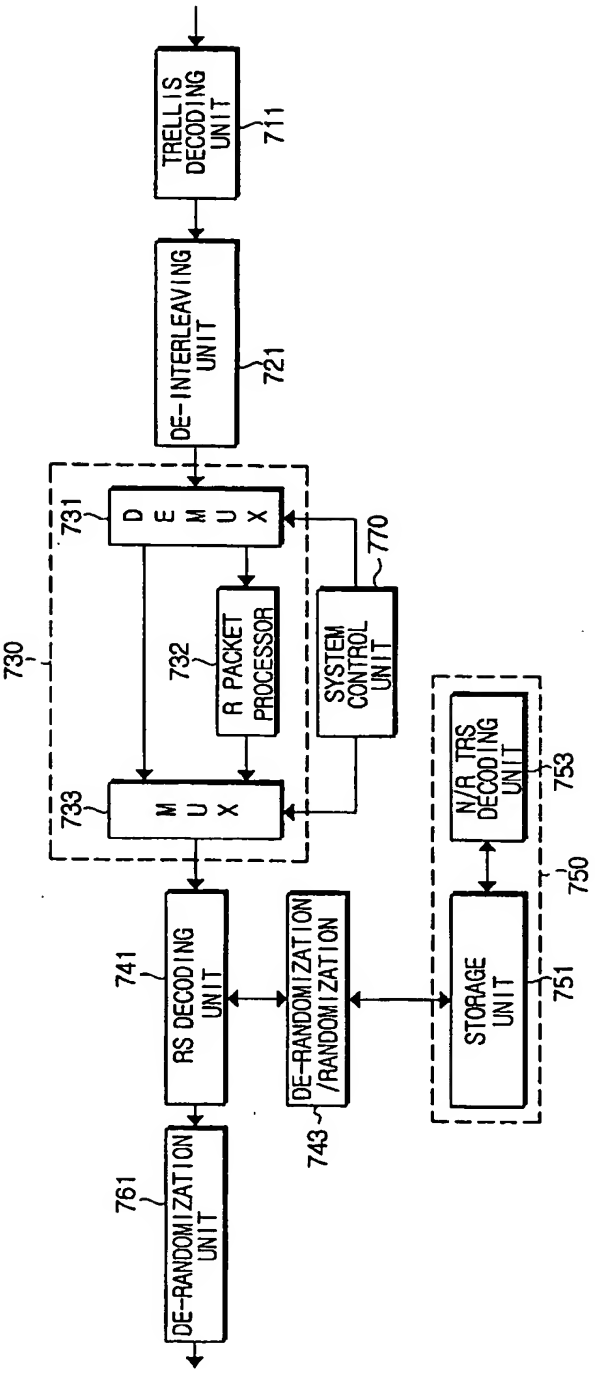
[Fig. 11]


START
S311
RANDOMIZE NORMAL DATA PACKETS AND ROBUST DATA PACKETS
S313
APPEND PARITIES TO THE NORMAL DATA PACKETS AND ROBUST DATA PACKETS
S315
STORE THE NORMAL DATA PACKETS AND ROBUST DATA PACKETS
S317
GENERATE PARITY PACKETS FOR THE NORMAL DATA PACKETS AND ROBUST DATA PACKETS
S319
INSERT HEADERS INTO THE GENERATED PARITY PACKETS
S321
RANDOMIZE THE PARITY PACKETS
S323
APPEND PARITIES FOR PARITY PACKETS
S327
SPLIT THE PACKETS INTO NORMAL DATA AND ROBUST DATA AND PROCESS THE DATA ACCORDING TO RESPECTIVE PACKET FORMATS
S328
INTERLEAVE IN BYTE
S329
APPLY THE TRELLIS ENCODING IN BIT
END

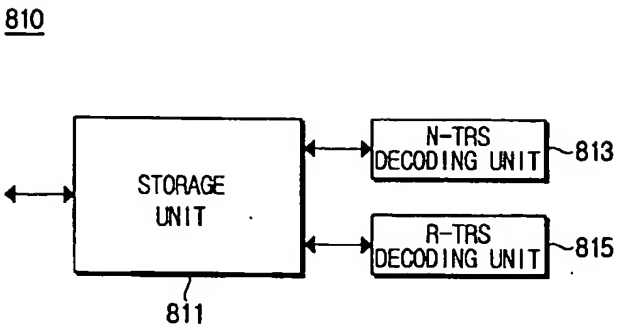
[Fig. 12]


610
612
613
N-TRS ENCODING UNIT
N-PID INSERTION UNIT
611
MPEG2-TS N/R PACKETS
STORAGE UNIT
R-TRS ENCODING UNIT
R-PID INSERTION UNIT
614
615

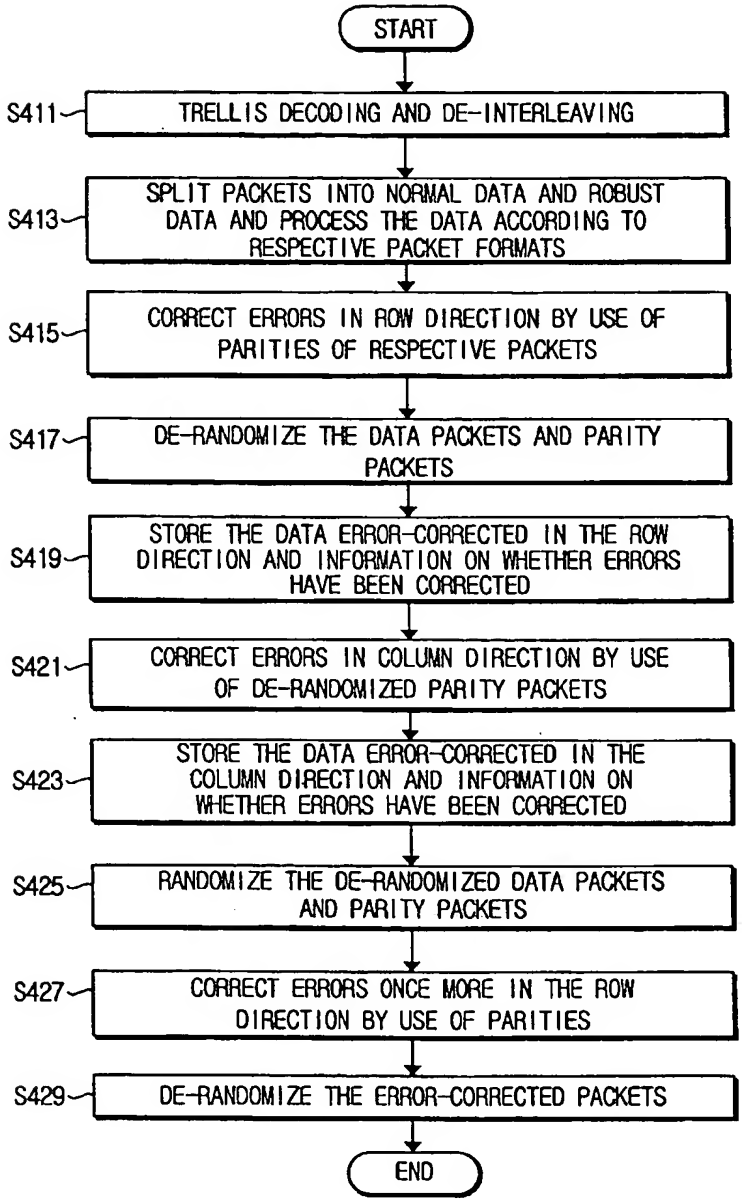
[Fig. 13]


TRELLIS DECODING UNIT
711
DE-INTERLEAVING UNIT
721
730
731
DEMUX
732
R PACKET PROCESSOR
770
SYSTEM CONTROL UNIT
733
MUX
741
RS DECODING UNIT
743
DE-RANDOMIZATION /RANDOMIZATION
761
DE-RANDOMIZATION UNIT
750
N/R TRS DECODING UNIT
753
STORAGE UNIT
751

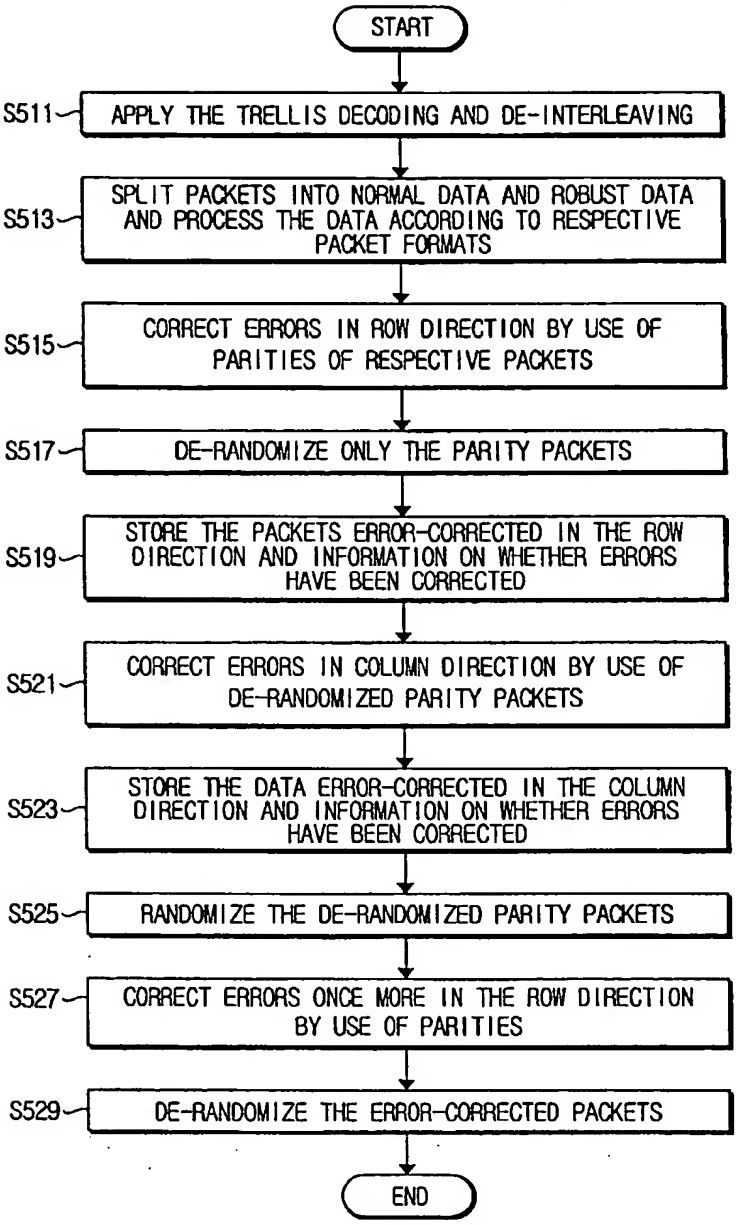
[Fig. 14]


810
STORAGE UNIT
811
N-TRS DECODING UNIT
813
R-TRS DECODING UNIT
815

[Fig. 15]


START
S411
TRELLIS DECODING AND DE-INTERLEAVING
S413
SPLIT PACKETS INTO NORMAL DATA AND ROBUST DATA AND PROCESS THE DATA ACCORDING TO RESPECTIVE PACKET FORMATS
S415
CORRECT ERRORS IN ROW DIRECTION BY USE OF PARITIES OF RESPECTIVE PACKETS
S417
DE-RANDOMIZE THE DATA PACKETS AND PARITY PACKETS
S419
STORE THE DATA ERROR-CORRECTED IN THE ROW DIRECTION AND INFORMATION ON WHETHER ERRORS HAVE BEEN CORRECTED
S421
CORRECT ERRORS IN COLUMN DIRECTION BY USE OF DE-RANDOMIZED PARITY PACKETS
S423
STORE THE DATA ERROR-CORRECTED IN THE COLUMN DIRECTION AND INFORMATION ON WHETHER ERRORS HAVE BEEN CORRECTED
S425
RANDOMIZE THE DE-RANDOMIZED DATA PACKETS AND PARITY PACKETS
S427
CORRECT ERRORS ONCE MORE IN THE ROW DIRECTION BY USE OF PARITIES
S429
DE-RANDOMIZE THE ERROR-CORRECTED PACKETS
END

[Fig. 16]


START
S511
APPLY THE TRELLIS DECODING AND DE-INTERLEAVING
S513
SPLIT PACKETS INTO NORMAL DATA AND ROBUST DATA AND PROCESS THE DATA ACCORDING TO RESPECTIVE PACKET FORMATS
S515
CORRECT ERRORS IN ROW DIRECTION BY USE OF PARITIES OF RESPECTIVE PACKETS
S517
DE-RANDOMIZE ONLY THE PARITY PACKETS
S519
STORE THE PACKETS ERROR-CORRECTED IN THE ROW DIRECTION AND INFORMATION ON WHETHER ERRORS HAVE BEEN CORRECTED
S521
CORRECT ERRORS IN COLUMN DIRECTION BY USE OF DE-RANDOMIZED PARITY PACKETS
S523
STORE THE DATA ERROR-CORRECTED IN THE COLUMN DIRECTION AND INFORMATION ON WHETHER ERRORS HAVE BEEN CORRECTED
S525
RANDOMIZE THE DE-RANDOMIZED PARITY PACKETS
S527
CORRECT ERRORS ONCE MORE IN THE ROW DIRECTION BY USE OF PARITIES
S529
DE-RANDOMIZE THE ERROR-CORRECTED PACKETS
END

INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2004/002782

A. CLASSIFICATION OF SUBJECT MATTER

IPC7 H04N 7/24

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC H04N

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
Korean Patents and Applications for Inventions since 1975

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
NPS: "error correction encoding, digital broadcasting, Transversal Reed-Solomon encoding, ATSC, randomization, trellis encoding, MPEG(motion picture expert group)"

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2002/0191712 A1 (KONINKLIJKE PHILIPS ELECTRONICS N.V.) 19 December 2002 See the whole document	1-62
A	US 2002/0194570 A1 (KONINKLIJKE PHILIPS ELECTRONICS N.V.) 19 December 2002 See the whole document	1-62
A	US 2003/0099303 A1 (KONINKLIJKE PHILIPS ELECTRONICS N.V.) 29 May 2003 See the whole document	1-62
P	US 2004/0057535 A1 (ATI Technologies Inc.) 25 March 2004 See the whole document	1-62

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents,such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
28 JANUARY 2005 (28.01.2005)	**28 JANUARY 2005 (28.01.2005)**

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Telephone No. 82-42-481-8174

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/KR2004/002782

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		WO 2002100026 A1	12-12-2002
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		KR 1020040014977 A	18-02-2004
		WO 03003747 A1	09-01-2003
US 2004/0057353 A1	25-03-2004	None	